II.

ON SOME NORTH AMERICAN SPECIES OF LABOULBENIACEÆ.

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Presented by W. G. Farlow, February 12, 1890.

Note. — The following is intended as a preliminary communication on American Laboulbeniaceæ, which it is my purpose to supplement as soon as practicable by a more extended account, to form the second part of a proposed monograph of Entomogenous Plants, of which the first, on the Entomophthoreæ of the United States,* has already appeared. Illustrations of the new species described in this paper cannot well be given in the present connection, but will accompany my complete account of the subject when it is published.

The Laboulbeniaceae constitute a small group of fungi, without close affinities among other known Ascomycetes, the members of which are remarkable both in their structure and development, as well as peculiar for their external parasitism upon insects of several orders. Up to the present time little has been recorded concerning them in this country, and the total number of forms at present known represent only fifteen described species. Of these twelve are European, distributed among five genera: *Laboulbenia*, *Stigmatomyces*, *Helminthophana*, *Chitonomyces*, and *Hæmatomyces*. Of the remaining species, two are South American, belonging to the genus *Laboulbenia*, while the single representative of the group as yet recorded from this country has been described as *Appendicularia entomophila* Peck,† a genus, as will be presently noted, synonymous with *Stigmatomyces* Karsten.

Our present knowledge of the group rests chiefly upon the writings of Robin, ‡ Karsten, § and Peyritsch, ‖ the first notice of any member

* Memoirs of the Boston Society of Natural History, Vol. IV. No. VI. (1888).

† Thirty-eighth Rep. N. Y. State Mus. of Nat. Hist., p. 95, Plate III. figs. 1–4.

‡ Robin, Hist. Nat. d. Veget. Paras. etc., Paris, 1853, p. 622.

§ Chemismus d. Pflanzenzelle, Wien, 1869, p. 78.

‖ Sitz. d. Kaiserl. Acad. d. Wissensch. Wien, (1871) LXIV Band, 1 Abth., p. 441; (1873) LXVIII Band, 1 Abth., p. 227; (1875) LXXII Band, 3 Abth.

of the family being apparently that of the entomologist Rouget.* The family has, moreover, received attention from a zoölogical point of view, the genus of Vermes, *Arthrorhynchus*, having been founded by Kolenati † on species parasitic upon *Nycteribia* (Dipterous parasites of bats).

The members of the family may be briefly described as consisting usually of a main subclavate, flattened body, which for lack of a better term may be called the *receptacle;* simple, made up of a few large cells and bearing at its distal end one or more perithecia; or compound, the divisions bearing solitary perithecia. Within the perithecia, asci are developed by successive sprouting from basal initial cells. The asci contain apparently eight spores, although this number has been definitely observed in a single species only. The spores, which are hyaline, usually fusiform, once septate, and more or less involved in mucus, are expelled through the elastic apical pore of the perithecium, the ascus wall, as in other well known instances, disappearing before the discharge takes place. The spores become attached by one extremity to the surface of the host, and by subsequent division produce a new individual, without forming hyphæ or a mycelium of any sort. The point by which the spore is attached becomes modified into a dark, horny-looking piece, which penetrates the chitinous integument of the insect, and forms the single medium of nutrition as well as of attachment.

In addition to the perithecium certain other bodies, bearing a definite relation to it, are always present, borne usually on the receptacle close beside the perithecium; in two genera (*Helminthophana* and *Cantharomyces*) arising near the base of the receptacle. These bodies, or appendages, have been called *paraphyses*, or better *pseudoparaphyses;* and are of great morphological as well as systematic importance, varying greatly in the different genera and species. Although certain of these appendages are usually sterile, there seems no reasonable doubt that one of them, at least, is always functional as an antheridium, or more commonly bears certain organs which are functional as antheridia. From these Karsten has observed the production of bodies which he considers antherozoids; but confirmatory observations, other than his own, are lacking.

In *Laboulbenia*, the only genus which the writer has been able to examine with any thoroughness in its different stages, the supposed

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* Ann. d. l. Soc. Entomol. d. France, Tom. VIII. p. 21 (1850), sec. Robin.

† Wiener Entomol. Monatschrift, 1857, Band I. p. 66, sec. Peyritsch.

antheridia are always bottle- or flask-shaped, and borne on the pseudoparaphysis next to the perithecium. These peculiar bodies, which appear to have been overlooked by Peyritsch, or whose importance does not seem to have been appreciated by him, arise from the lower septæ of the pseudoparaphyses, or are sometimes terminal on short branches. They are invariably present, as far as the writer's observations indicate, just before fertilization takes place, disappearing as the perithecium matures; so that in the adult plant there is commonly no vestige of them.

Fertilization is accomplished through the medium of a body which must be considered a trichogyne, and is connected directly with the cell from which the asci subsequently arise. The character of the trichogyne varies in different genera, and in *Laboulbenia* may reach a remarkable degree of development, giving rise to branches, the tips of which may be coiled in a definitely spiral manner. The trichogyne is even more short-lived than the supposed antheridia, disappearing as soon as any development is observable in or about the central cell with which it is connected. Whether it is fertilized through the agency of minute round or oval bodies, frequently observed by the writer about the apices of the antheridia, more rarely within them, is quite uncertain, yet the observations of Karsten would point to this conclusion.

It may be mentioned that De Bary did not look upon the sexuality of these fungi with any favor, as may be inferred from his remark* that Peyritsch himself did not think very well of his (Peyritsch's) "attempt to save the trichogyne" by supposing a fertilization through contact with one of the pseudoparaphyses in the genus *Laboulbenia*. That a form of sexual reproduction is present, however, among the species of *Laboulbenia* at least, cannot in the writer's opinion be for a moment doubted by any one who has personally observed the more important stages of their development.

The immediate affinities of these most singular plants are, as has been mentioned, very uncertain; and their resemblance to some of the higher Algæ, through their supposed method of sexual reproduction, is striking and interesting in connection with the aquatic, or semi-aquatic, habit of many of them. That they are fungi, and at the same time Ascomycetous, seems beyond question. Why, therefore, they should be placed by De Bary and others among *doubtful* Ascomycetes, is not apparent.

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* Comp. Morphol. and Biol. of Fungi, etc., English ed., p 275.

In the following descriptions the term *receptacle* has been used to designate the main body of the fungus; the side from which the perithecium springs being spoken of as the *inner*, while that bearing the pseudoparaphyses is spoken of as the *outer*, where this distinction is possible. The first two superposed "stem cells" of the receptacle are spoken of as the *basal* and *supra-basal* cells.

STIGMATOMYCES Karsten (1871).

Stigmatomyces entomophila (Peck).

Appendicularia entomophila Peck, l. c.
Appendiculina entomophila Berlese, Malpighia, Vol. III. p. 59.

Through the kindness of its discoverer, the Rev. J. L. Zabriskie, the writer has been enabled to examine authentic specimens of this interesting and distinct species, which proves to belong without question to the present genus. The antheridial appendage is proportionately somewhat smaller than in its near ally (*S. Baeri* (Knoch) Karst.), but has the same peculiar structure and bears the same relation to the perithecium; and structural differences which could separate it generically are wholly wanting. Berlese in the paper referred to calls attention to the fact that *Appendicularia* has been preoccupied among the *Melastomaceae*, and proposes the substitution of *Appendiculina*, which, however, proves to be needless.

PEYRITSCHIELLA nov. gen.

Receptacle composed of two superposed basal cells, above which it is multicellular, one cell on the inner side forming a short, sharp projection. Perithecium one, sometimes two; when single, terminal, nearly median, subconical, the spreading apex symmetrically four-lobed. Pseudoparaphyses arising from several different points on either side of the receptacle.

Peyritschiella curvata nov. sp.

Characters of the genus. Usually strongly curved, colorless except the large, jet-black piece of attachment, and the bases of the pseudoparaphyses which are also black and strongly constricted in the middle. Paraphyses colorless, cylindrical or subclavate, septate or obscurely septate; arising in three to five groups, each made up of from one to three pseudoparaphyses, and placed alternately at different

points on either side of the receptacle. Total length to tip of perithecium 280–300 μ. Perithecium 90–100 $\mu \times$ 22–29 μ. Spores fusiform, asymmetrically once septate, involved in mucus, 26 $\times$ 4 μ. Pseudoparaphyses sometimes 60 μ in length.

Host, *Platynus cincticollis*. Connecticut.

This genus appears to differ from other known genera in the presence of several groups of paraphyses on both sides of the receptacle. The presence of two perithecia was only observed in a single specimen. The perithecium resembles that of *Helminthophana* in being symmetrical at the apex. The genus is named in memory of the late Dr. Peyritsch, as a slight recognition of his well known and admirable work upon this family.

CANTHAROMYCES nov. gen.

Receptacle simple; or compound above the supra-basal cell, from which one or more divisions may arise, each bearing a solitary perithecium. Pseudoparaphyses, one or more, arising from the supra-basal cell. Perithecium median, tapering towards its symmetrical apex.

Cantharomyces verticillata nov. sp.

Color pale yellowish. Perithecium expanding slightly above its base, then tapering slowly towards its slightly truncate, conical apex. Pseudoparaphyses arising in a whorl of two to four (the number apparently variable) from the small supra-basal cell; simple or branched; once or twice constricted at the septæ; the joints short, stout, and broader towards their rounded apices. A single simple pseudoparaphysis composed of cylindrical segments hardly constricted at the septæ arises also from the distal end of the third stem cell. Receptacle simple, composed of five single superposed cells, arising from a small black piece of attachment, the first four nearly cylindrical, the fifth short, slightly expanded towards the base of the perithecium, which is made up of two or three very small cells. The supra-basal cell is squarish about half the length of the basal. The third and fourth cells are nearly similar, somewhat longer than the basal and supra-basal taken together. Spores fusiform, apparently once septate, and about 18–20 $\mu \times 3\ \mu$ (these were only examined, however, *within* the perithecium). Perithecia 90–127 $\mu \times$ 18–26 μ. Pseudoparaphyses 50–125 μ. Receptacle 75–125 $\mu \times 11\ \mu$.

On *Sunius longiusculus*. Anna, Ill. (S. A. Forbes).

Cantharomyces Blidii nov. sp.

Color yellowish. Perithecia subconical, one or more in number, each borne at the summit of a division of the receptacle arising from the supra-basal cell. Pseudoparaphyses one, rarely more, arising from the supra-basal cell: composed of three superposed basal cells, the second swollen, longitudinally septate; the third squarish, small, surmounted by one or two small cells, from which arise a variable number of slightly curved, septate, slender branches themselves variably once or twice branched. Receptacle simple or compound; the basal and sub-basal cells rather short, the lower and outer portions of the wall of the latter often thickened, deep black, and indented; but sometimes without signs of this modification. The supra-basal cell may give rise to one or more divisions of the receptacle, which are sub-lateral in position, and consist of a long, cylindrical basal cell, surmounted by a broader short cell, divided longitudinally by a median septum, and bearing the perithecium directly. Spores slender, fusiform, involved in mucus, asymmetrically once septate, $25 \times 3.5\ \mu$. Perithecia 92.5–130 $\mu \times$ 33–55 μ, average $114 \times 42\ \mu$. Pseudoparaphyses, total length 90–180 μ, average 150 μ. Total length to tip of perithecia 200–370 μ, average 280 μ.

On *Blidius assimilis*. Champaign, Ill. (S. A. Forbes).

I am greatly indebted to the kindness of Professor Forbes for specimens of the two singular forms above described. The material of *C. verticillata* consisted of but four adult specimens, so that further study may show the presence of a compound receptacle in this species as well as in *C. Blidii*, where it was observed in only a few of the twenty or more individuals examined. The secondary pseudoparaphysis of *C. verticillata* is wholly wanting in *C. Blidii*.

LABOULBENIA Montagne et Robin (1853).

Laboulbenia elongata nov. sp.

Color brown or blackish. Perithecium long-ovoid, darker just below its hyaline apical pore. Pseudoparaphyses arising from a black basal disk; two in number, brown to blackish, sometimes hyaline near their extremities, septate, slightly constricted at the septæ; their basal cells distinct, the inner giving rise immediately to two branches which may be either simple or once or twice dichotomously branched. The outer pseudoparaphysis usually once or twice dichotomously branched

above the supra-basal cell. Receptacle composed of seven main cells; the basal nearly triangular, the supra-basal elongate, cylindrical, often three times as long as the basal. Above the supra-basal cell the receptacle is divided by a longitudinal partition into two cells, that on the inner side smaller, and separated from the base of the perithecium by a single, usually squarish cell, above which are two small triangular cells, an outer and an inner, sometimes connected, which form the base of the perithecium. The two remaining cells of the receptacle bear the disk-like base of the pseudoparaphyses, and consist of an outer larger one, separated by an oblique partition, on its upper inner side, from the smaller inner one. Spores fusiform, hyaline, granular, involved in mucus, septate near one extremity, 75–80 $\mu \times$ 6.5–8 μ. Perithecia 135–170 $\mu \times$ 65–70 μ. Pseudoparaphyses 200–725 μ. Length to tip of perithecium 450–600 μ; average 538 μ. Maximum total length to tip of pseudoparaphyses 950 μ.

On *Platynus cincticollis*. Connecticut.

This species, which is the largest known representative of the genus, being easily visible to the naked eye, is allied to *L. Nebriæ* and *L. flagellata*, resembling the latter in appearance, but easily separable from it by its great size and the details of its structure. Its trychogyne is remarkable for its unusual development, being often several times branched, and otherwise peculiar from the spiral twisting of one or more of its ultimate branches.

Laboulbenia brachiata nov. sp.

Color brown to blackish. Perithecia long-ovoid, darker towards the hyaline apex. Pseudoparaphyses blackish, or nearly hyaline; each on a small black basal disk; arising from an oblique cellular base; ten in number in a double row of five pairs; septate, the basal and sub-basal joints often inflated, especially in the outer larger pairs; dichotomously once to twice branched above the basal and sub-basal joints, the ultimate branches often very long and attenuated. Receptacle consisting of single basal and supra-basal cells, the latter slightly the longest, above which are two cells, that on the inner side the largest: above and between these two cells is a third smaller, central one, and on the inner side of this another, slightly larger cell, is separated from the perithecium by two small flat cells which form its base and are sometimes confluent. The remaining cells of the receptacle form the base from which the pseudoparaphyses arise, which is made up of five obliquely superposed cells, decreasing in size from below upwards, and separated from the pseudoparaphyses

by a row of small cells from which the latter spring directly. Spores hyaline, fusiform, septate near one extremity, surrounded by a gelatinous envelope, 60 × 5 μ. Perithecia 150–120 μ × 50–60 μ. Paraphyses, short 150–180 μ; long 700–740 μ. Total length to tip of perithecium 400–450 μ. Maximum length to tip of paraphyses 950 μ.

On *Patrobus longicornis*. Connecticut; (Maine, Dr. Townsend).

A remarkable form, nearly if not quite as large as the preceding species, and resembling a minute crustacean from its many projecting appendages. It is allied in the structure of its receptacle to the species figured by Peyritsch (l. c. 1873, Plate I. fig. 9), and referred by him to *L. fasciculata;* a manifest error, as a glance at the mature plant (fig. 8) must show.

Laboulbenia Rougetii Mont. et Robin.

Laboulbenia Rougetii Mont. et Robin, Hist. Nat. d. Veg. Paras., p. 622, Plate X. fig. 2.

To this species I have referred a form occurring on *Platynus*, which corresponds so closely to Robin's figures that I am inclined, for the present, to consider it merely a variety of this species. A comparison of more extensive material than I possess may show that it is distinct; yet the early stages, as well as the mature individuals, show such slight variations from the figures of *Rougetii* that it would be unsafe, at present, to refer it to any other species.

On *Platinus cincticollis*. Connecticut.

Laboulbenia fumosa nov. sp.

Color smoky brown with an olive tinge. Perithecium long-ovoid or ovoid, the apex with its hyaline pore often truncate, hardly oblique. Pseudoparaphyses arising from a base of three or four cells, itself seated on a thin black disk. Pseudoparaphyses arising from three or four inner basal cells, the walls of which are not distinct. From the outer of these basal cells extends a row of cells curving outwards and downwards (this portion is commonly broken off in specimens), black beneath, and giving rise to a variable number of straight, erect, simple, colorless branches. The inner basal cells give rise to numerous branches, erect, slender, septate, colorless, sometimes ten in number, often twice as long as the perithecium; the shorter, inner branches sometimes subclavate. Receptacle broad, tapering somewhat abruptly to its usually slender basal cell; supra-basal cell larger, broad: above it, on the inner side, two cells which separate it from the perithecium, which is itself seated on two or three small cells; above it, on the

outer side, two larger cells, which separate it from the cellular base from which the pseudoparaphyses arise; the upper of these two cells divided by a curved partition wall, which cuts off its upper inner corner. Spores fusiform, septate near one extremity, involved in mucus, 55–60 $\mu \times 5$–5.5 μ. Perithecia 120–130 $\mu \times 50$–75 μ. Pseudoparaphyses (longer) 75–230 μ. Length to tip of perithecium 250–300 μ. Greatest width 75–100 μ.

On *Platynus cincticollis*. Connecticut.

A small species occurring almost invariably at the apex of the elytra, rarely on the abdomen of its host. It is nearly related to *L. luxurians*, from which it is readily distinguished by its long, straight pseudoparaphyses.

Laboulbenia Harpali nov. sp.

Hyaline or very slightly straw-colored. Perithecia long-ovoid, sometimes tinged with brown, the apex (in mature specimens) black, except about the pore; longitudinal axis nearly parallel with that of the receptacle. Pseudoparaphyses hyaline, arising from a black basal disk placed opposite the middle of the perithecium; two in number, their basal cells connected; the outer irregularly once or twice dichotomously branched; the inner usually consisting of two short branches arising directly from the inner basal cell. Receptacle slender; consisting of two large stem cells (basal and supra-basal), and above them on the inner side a subspherical cell is separated from the perithecium by three very small cells. On the outer side the two cells below the pseudoparaphyses are present, the upper having the usual oblique partition in its upper inner angle. Spores fusiform, septate near one extremity, involved in mucus, 60–68 $\mu \times 5$–5.5 μ. Length to tip of perithecium 290 μ (215–300 μ). Length of outer pseudoparaphyses 200–300 μ; of inner 100–130 μ. Perithecia 90 $\times$ 40 μ.

On *Harpalus Pennsylvanicus*. Connecticut; Maine (Kittery).

This species occurs upon the inferior surface of its host, always on the left side of the anterior, inferior face of the abdomen, sometimes extending across to the adjacent portion of the thorax. It is not uncommon, and occurs frequently in company with the succeeding species, never mixed with it, however.

Laboulbenia elegans nov. sp.

Hyaline. Perithecia ovoid; the longitudinal axis at an angle of about 40° to that of the receptacle; apex jet-black (only in mature specimens), except around the pore. Pseudoparaphyses arising from

a jet-black disk, nearly opposite the base of the perithecium; two in number, their basal cells connected. The outer basal cell giving rise to two branches; an inner, once dichotomously branched, and an outer, always simple. The inner basal cell very small, giving rise to several short branches, slightly curved, often subclavate, sometimes once branched, bearing numerous lateral or terminal antheridia. Receptacle similar to that of the preceding species, the cells merely varying in their relative proportions. Spores fusiform, septate near one extremity, involved in mucus, 40–50 $\mu \times 4$–5 μ. Length to tip of perithecium 290 μ. Length of outer pseudoparaphyses 250–400 μ; of inner 50–75 μ. Perithecia 110–130 $\mu \times 50$–65 μ.

On *Harpalus Pennsylvanicus*. Connecticut; Maine (Kittery).

A very pretty and distinct species, allied to the preceding; but separable at once by the position and character of its pseudoparaphyses. It is the only species observed by the writer, in which the sterile pseudoparaphysis appears to be invariable in its mode of branching. The species occurs in single tufts on the inferior surface of the thorax of its host, always on the right side.